

CLAIMS

What is claimed is:

1. A method, comprising:
providing a membrane and electrode assembly having one or more electrocatalysts in intimate contact with a cation exchange membrane in an alkali metal cation form during a period without an electrical current passing through the membrane and electrode assembly.
2. The method of claim 1, wherein at least one of the one or more electrocatalysts has an electrocatalytic activity that diminishes when placed in contact with a hydrated proton form of the cation exchange membrane in the absence of an electrical current flowing through the cell.
3. The method of claim 2, wherein the electrocatalytic activity diminishes by a process selected from degradation, dissolution, corrosion, or a combination thereof.
4. The method of claim 1, wherein the one or more electrocatalysts includes lead dioxide.
5. The method of claim 1, further comprising:
placing the membrane and electrode assembly into an electrochemical cell or an electrochemical cell stack.
6. The method of claim 5, wherein the electrochemical cell or electrochemical cell stack includes a fuel cell or an electrolytic cell.
7. The method of claim 1, wherein the cation exchange membrane is hydrated.
8. The method of claim 1, wherein the cation exchange membrane is dry.

9. The method of claim 1, further comprising:
 - supplying the membrane and electrode assembly with reactants; and
 - providing an electrical current through the membrane and electrode assembly to liberate protons and convert the cation exchange membrane from the alkali metal cation form to an acidic proton form.
10. The method of claim 1, further comprising:
 - placing the membrane and electrode assembly into an electrochemical cell or an electrochemical cell stack.
11. The method of claim 10, wherein the cation exchange membrane is wet during the placing of the membrane and electrode assembly into the electrochemical cell or the electrochemical cell stack.
12. The method of claim 10, wherein the cation exchange membrane is dry during the placing of the membrane and electrode assembly into the electrochemical cell or the electrochemical cell stack.
13. A method, comprising:
 - providing a membrane and electrode assembly having one or more electrocatalysts in intimate contact with a cation exchange membrane in a dry proton form during a period without an electrical current passing through the membrane and electrode assembly.
14. The method of claim 13, wherein at least one of the one or more electrocatalysts has an electrocatalytic activity that diminishes when placed in contact with a hydrated proton form of the cation exchange membrane in the absence of an electrical current flowing through the cell.
15. The method of claim 14, wherein the electrocatalytic activity diminishes by a process selected from degradation, dissolution, corrosion, or a combination thereof.

16. The method of claim 13, wherein the one or more electrocatalysts includes lead dioxide.
17. The method of claim 13, further comprising:
placing the membrane and electrode assembly into an electrochemical cell or an electrochemical cell stack.
18. The method of claim 17, wherein the electrochemical cell or electrochemical cell stack includes a fuel cell or an electrolytic cell.
19. The method of claim 13, further comprising:
supplying the membrane and electrode assembly with water to convert the proton exchange membrane from the dry proton form to a hydrated acidic form.
20. The method of claim 13, further comprising:
placing the membrane and electrode assembly into an electrochemical cell or electrochemical cell stack in a dry condition.
21. The method of claim 13, further comprising:
supplying the membrane and electrode assembly with water to convert the proton exchange membrane from the dry proton form to a hydrated acidic form; and
providing an electrical current through the membrane and electrode assembly to liberate protons and convert the proton exchange membrane from the proton non-conducting form to a wet acid form.
22. The method of claim 21, wherein the steps of supplying water and providing an electrical current are performed simultaneously or nearly simultaneously.

23. The method of claim 20, wherein the electrochemical cell or electrochemical cell stack is selected from an electrolyzer and a fuel cell.

24. A method, comprising:

providing a membrane and electrode assembly having one or more electrocatalysts in intimate contact with a cation exchange membrane in a sulfonyl-fluoride form during a period without an electrical current passing through the membrane and electrode assembly.

25. The method of claim 24, wherein at least one of the one or more electrocatalysts has an electrocatalytic activity that diminishes when placed in contact with a hydrated proton form of the cation exchange membrane in the absence of an electrical current flowing through the cell.

26. The method of claim 25, wherein the electrocatalytic activity diminishes by a process selected from degradation, dissolution, corrosion, or a combination thereof.

27. The method of claim 24, wherein the one or more electrocatalysts includes lead dioxide.

28. The method of claim 24, further comprising:

placing the membrane and electrode assembly into an electrochemical cell or an electrochemical cell stack.

29. The method of claim 28, wherein the electrochemical cell or electrochemical cell stack includes a fuel cell or an electrolytic cell.

30. The method of claim 24, further comprising:

converting the cation exchange membrane from the sulfonyl-fluoride form to an alkali metal cation form.

31. The method of claim 30, wherein the step of converting includes contacting the cation exchange membrane with an alkali metal hydroxide solution.
32. The method of claim 31, wherein the alkali metal hydroxide is selected from NaOH, KOH, LiOH, RbOH, CsOH, FrOH, and combinations thereof.
33. The method of claim 31, wherein the alkali metal hydroxide solution has a concentration of between about 0.1M and about 10M.
34. The method of claim 31, wherein the alkali metal hydroxide solution has a concentration of between about 0.5M and about 5M.
35. The method of claim 31, wherein the alkali metal hydroxide solution has a concentration of between about 0.75M and about 3M.
36. The method of claim 31, wherein the alkali metal hydroxide solution contacts the proton exchange membrane for between about 0.25 hours and about 24 hours.
37. The method of claim 31, wherein the alkali metal hydroxide solution contacts the proton exchange membrane for between about 0.5 hours and about 12 hours.
38. The method of claim 31, wherein the alkali metal hydroxide solution contacts the proton exchange membrane for between about 1 hour and about 6 hours.
39. The method of claim 30, further comprising:
providing the cation exchange membrane in a wet state.
40. The method of claim 30, further comprising:
providing the cation exchange membrane in a dry state.

41. The method of claim 30, further comprising:
assembling the membrane and electrode assembly into an electrochemical cell or an electrochemical cell stack.
42. The method of claim 41, wherein the cation exchange membrane is wet during the assembling of the membrane and electrode assembly into the electrochemical cell or the electrochemical cell stack.
43. The method of claim 41, wherein the cation exchange membrane is dry during the assembling of the membrane and electrode assembly into the electrochemical cell or the electrochemical cell stack.
44. The method of claim 30, further comprising:
supplying the membrane and electrode assembly with reactants; and
providing an electrical current through the membrane and electrode assembly to liberate protons and convert the cation exchange membrane from the alkali metal cation form to an acidic proton form.
45. The method of claim 44, wherein the steps of supplying reactants and providing an electrical current are performed simultaneously or nearly simultaneously.
46. A method, comprising:
passing electrical current through a membrane and electrode assembly having one or more electrocatalysts in intimate contact with a cation exchange membrane in a hydrated proton form; and then
supplying an alkali metal hydroxide solution to a membrane and electrode assembly under an electrical potential; and then

removing an electrical potential from across the membrane and electrode assembly, wherein the proton exchange membrane is converted from the hydrated proton form to the alkali metal cation form.

47. The method of claim 46, further comprising:
removing the alkali metal hydroxide solution from the electrochemical cell.
48. The method of claim 46, further comprising:
supplying the electrochemical cell with reactants; and
restoring the electrical potential across the electrochemical cell to liberate protons and convert the proton exchange membrane from the alkali metal cation form back to the acidic form.
49. The method of claim 46, wherein the alkali metal hydroxide is selected from NaOH, KOH, LiOH, RbOH, CsOH, FrOH and combinations thereof.
50. The method of claim 49, wherein the alkali metal hydroxide solution has a concentration of between about 0.1M and about 10M.
51. The method of claim 49, wherein the alkali metal hydroxide solution has a concentration of between about 0.5M and about 5M.
52. The method of claim 49, wherein the alkali metal hydroxide solution has a concentration of between about 0.75M and about 3M
53. The method of claim 45, wherein the step of converting the proton exchange membrane further comprises:
contacting the proton exchange membrane with the alkali metal hydroxide solution for a period between about .25 hour and about 24 hours.

54. The method of claim 53, wherein the period is between about 0.5 hours and about 12 hours.
55. The method of claim 53, wherein the period is between about 1 hour and about 6 hours.
56. A device, comprising:
a membrane and electrode assembly having one or more electrocatalysts in contact with a membrane in an alkali metal cation form, wherein at least one of the one or more electrocatalysts is characterized by an electrocatalytic activity that diminishes when placed in contact with a hydrated proton form of the cation exchange membrane in the absence of an electrical current through the cell.
57. The device of claim 56, wherein the membrane and electrode assembly is assembled into an electrochemical cell.
58. The device of claim 57, wherein the electrochemical cell is selected from a fuel cell and an electrolytic cell.
59. The device of claim 57, wherein the membrane and electrode assembly is disposed between an anode flow field and a cathode flow field.
60. The device of claim 57, wherein the electrochemical cell is disposed in an electrochemical cell stack.
61. The device of claim 56, wherein the one or more electrocatalysts includes lead dioxide.

62. A device, comprising:

a membrane and electrode assembly having one or more electrocatalysts in contact with a membrane in a sulfonyl-fluoride form, wherein at least one of the one or more electrocatalysts is characterized by an electrocatalytic activity that diminishes when placed in contact with a hydrated proton form of the cation exchange membrane in the absence of an electrical current through the cell.

63. The device of claim 62, wherein the membrane and electrode assembly is assembled into an electrochemical cell.

64. The device of claim 63, wherein the electrochemical cell is selected from a fuel cell and an electrolytic cell.

65. The device of claim 64, wherein the membrane and electrode assembly is disposed between an anode flow field and a cathode flow field.

66. The device of claim 63, wherein the electrochemical cell is disposed in an electrochemical cell stack.

67. The device of claim 62, wherein the one or more electrocatalysts includes lead dioxide.

68. A device, comprising:

a membrane and electrode assembly having one or more electrocatalysts in contact with a membrane in a dry proton form, wherein at least one of the one or more electrocatalysts is characterized by an electrocatalytic activity that diminishes when placed in contact with a hydrated proton form of the cation exchange membrane in the absence of an electrical current through the cell.

69. The device of claim 68, wherein the membrane and electrode assembly is assembled into an electrochemical cell.
70. The device of claim 69, wherein the electrochemical cell is selected from a fuel cell and an electrolytic cell.
71. The device of claim 69, wherein the membrane and electrode assembly is disposed between an anode flow field and a cathode flow field.
72. The device of claim 69, wherein the electrochemical cell is disposed in an electrochemical cell stack.
73. The device of claim 68, wherein the one or more electrocatalysts includes lead dioxide.